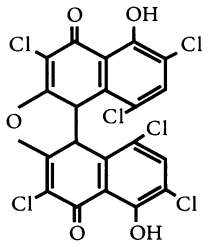
Don't Ban Chlorine—Use It Wisely

Recently, various activist and environmental groups have called for a ban on the use of chlorine and chlorine-containing compounds (*1,2*). The questions at issue are 1) is it possible, and 2) is it wise? Of course, chlorine, as chloride ion, is an essential component of the body, where it occurs at high levels in plasma and interstitial fluid. There probably is no controversy concerning this aspect of chlorine.

However, is it really possible to ban chlorine-containing compounds from the environment? Many do not realize the great number and ubiquitous presence of such substances in the environment (*3,4*). Burning of wood, a fuel with possible increased use, both for domestic and industrial purposes, leads to the release of methyl chloride, a weak alkylating agent (*5*). Marine organisms form chloroform, carbon tetrachloride, chlorine-containing haloforms, and longer-chain compounds containing various halogens. It was once estimated that the natural formation of carbon tetrachloride was greater than industrial production in the entire Northern Hemisphere (*6*). The comment might be made that these examples are all aliphatic compounds; that only the more persistent cyclic compounds containing chlorine should be banned. But nature, the consumate master of synthesis, has an appreciable number of cyclic organics which contain chlorine in the repertoire. Ochratoxin, made by the fungus *Aspergillus ochraceus* (*7*), is an example of a toxic material with chlorine on an aromatic ring. On the other hand, naturally occurring chlorinated compounds such as chloramphenicol, chlortetracycline, and griseofulvin have been used to advantage against bacterial or mycotic diseases of humans (*8*). Various chlorinated phenols with antibiotic properties have been isolated from naturally occurring organisms, especially marine algae (*9,10*). A survey of many marine organisms showed that numerous products with antiviral, antimicrobial, and antineoplastic properties were present (*11*).



1,3, 6, 8, 11, 13,-Hexachloro-4, 10-dihydroxydinaphtho [2, 1-b′, 1′, 1′-d] furan-5, 9-dione is naturally occurring.

Not only marine organisms synthesize chlorinated substances; lichens (*12,13*), and even some plants, seem capable of incorporating chlorine atoms into their metabolites (*14*). Furthermore, a substance with a structure akin to that of a chlorinated dibenzofuran has been isolated from soil under decomposed roots of a type of eucalyptus tree (*15,16*). Thus, nature furnishes chlorinated compounds similar to some of the hazardous materials presumed to result only from technological activity.

Is it wise to ban chlorine and chlorine-containing compounds? Part of the reason for the longer life span of our population is the availability, due to chlorination, of a water supply free of the organisms that cause typhoid, cholera, and other infectious diseases. It is often stated that other methods of disinfecting water could be used. True, but their disinfecting power usually does not extend beyond the actual disinfection period, while with chlorine there is a residual period when the action remains. With the increase in urban population of the United States and the resultant more crowded cities, the residuum of action, as from chlorine, is probably desirable.

Furthermore, to ban chlorinated compounds may limit discoveries of potential new therapeutic agents. For example, a trichlorodibromooctene isolated from the red marine algae *Portiaria hornemannii* had an unusually high cytotoxic effect on chemoresistant human brain, kidney, and colon tumor cell lines in culture, leading to selection by the drug development group of the National Cancer Institute for further study (*17*). But if chlorine compounds are banned, further development may be "illegal." Fortunately, an anti-chlorine mentality has not prevented the development of 2-chlorodeoxyadenosine for the treatment of hairy-cell leukemia.

Currently, thousands of otherwise healthy but breast cancer-prone women are enrolled in clinical studies which use tamoxifen as a prophylactic agent against breast cancer. The hepatocarcinogenicity of tamoxifen in rats (*18*) and its propensity to form numerous DNA adducts (*19*) casts some doubt on the wisdom of this effort. On the other hand, the chlorinated analogue of tamoxifen, toremifene, although it also suppressed the spontaneous endocrine and mammary tumors of rats, did not cause liver cancer and did not form DNA adducts (*19*). Accordingly, based on animal studies, the chlorinated analogue appears safer than tamoxifen.

Thus, chlorine and its compounds should not be banned but used safely and properly in situations where their unique properties are necessary. Instead of an outright ban, scientifically based risk–benefit evaluations should be made for each substance.

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